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**SANDERS**  
A Lockheed Martin Company

DOCKET FILE COPY ORIGINAL

October 3, 1995

Mr. William F. Caton  
Acting Secretary  
Federal Communications Commission  
1919 M Street NW  
Washington DC 20554

RECEIVED

OCT 03 1995

FCC MAIL ROOM

Dear Mr. Caton:

Sanders presents for the record (reference Docket No. 94-102), pursuant to 47 CFR § 1.1206, our presentation to the FCC. This presentation was briefed in a meeting with John Cimko and members of his staff on September 27, 1995. An original and one copy of our presentation to Mr. Cimko and his staff are enclosed with this submission.

Respectfully submitted,

  
Gregory E. Webb  
General Manager  
Telecommunications Systems  
(603) 645-5460

Enclosure:

No. of Copies rec'd  
List ABCDE



**Ex Parte Presentation**

**RECEIVED**

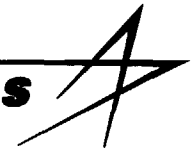
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**OCT 03 1995**

**ECC MAIL ROOM**

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**Telecommunications Systems**

# **Smart Look\* / Micro Look\* Cellular Phone Location Products**

Presented to  
**Federal Communications Commission**  
in response to Docket No. 94-102

**27 September 1995**

Two copies of this Presentation have been submitted to the Commission Secretary

\* TM Lockheed Sanders, Inc.

# Agenda



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## *Telecommunications Systems*

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- Program Overview
- Cellular Phone Location Products Systems Study
- Smart Look Wide Area Location System
- Micro Look Precision Location System
- Integrated Performance

# Telecommunications Products

## Key Objectives



### Telecommunications Systems

**Our Solution Supports an Economically Feasible, Location Performance of Less Than 125 Meters**

#### Cellular Location Criteria

- ① Work with existing installed base of over 25 million cellular phones
- ② Provide flexible integration into evolving E-9-1-1 infrastructure
- ③ Provide precise location accuracy
- ④ Provide for tracking the location of moving phones
- ⑤ Be cost effective and affordable on a system-wide basis
- ⑥ Be ready for a timely implementation

#### Solution

Smart Look /  
Micro Look  
Modular  
System

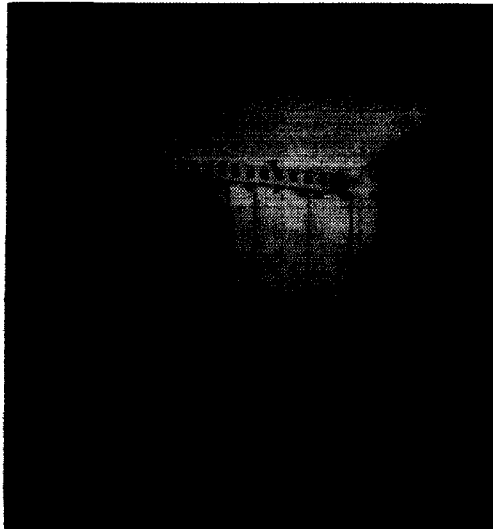
# Smart Look / Micro Look Cellular Phone Location Products



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*Telecommunications Systems*

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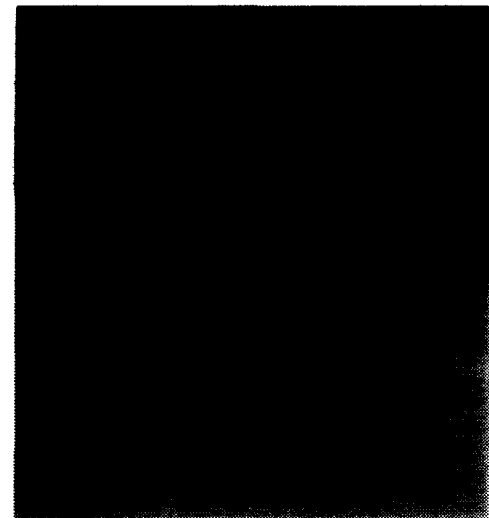


## **Smart Look Wide Area Location Products**

- Install in Existing Cellular Infrastructure
- Approximate Location

## **Micro Look Precision Location Products**

- Portable Units
- Precision Location to Cellular Phone
- 2-D and 3-D Detection Capability

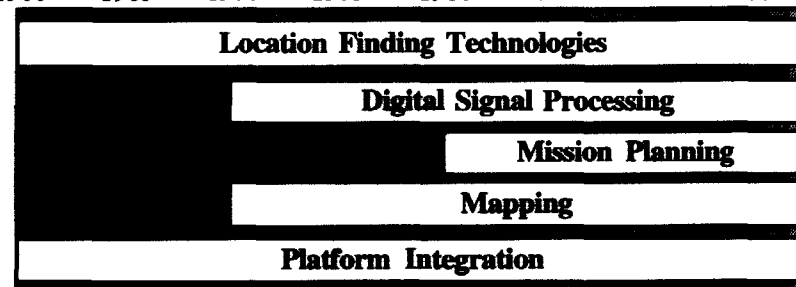


# Cellular Phone Location System Development Process



## Telecommunications Systems

1960 1965 1970 1975 1980 1985 1990 1995



### Sanders' Core Location Product Technologies

#### Requirements Analysis

- Stated FCC Regulations Performance Schedule
- Industry Analysis NENA, Driscoll JEM-TIA
- User Surveys - Cell Carriers, PSAPs, Dispatchers, OEMs, Emergency Responders
- Existing Infrastructures: Systems, Operations, Facilities (Cell, E-9-1-1, TelCo's Dispatchers.)
- Operational Analysis
- Derived Requirements Performance DTC Supportability Design/Construction

#### System/Subsystem Trade Studies

- Alternative Approaches
- Predicted/Measured Performance
- Cost
- Supportability
- Risk Analysis

#### System Design

- Requirements Allocations
- System/Subsystems Hardware/Software ICDs
- User Interfaces
- Supportability
- DTUPC

#### Build/Integrate Product/Services

- Performance Test
- Design/Construction
- FCC/UL
- User Interface Testing
- System Integration Cell Carriers Phone Systems 911 Systems PSAPs/Users

#### Operational Verification

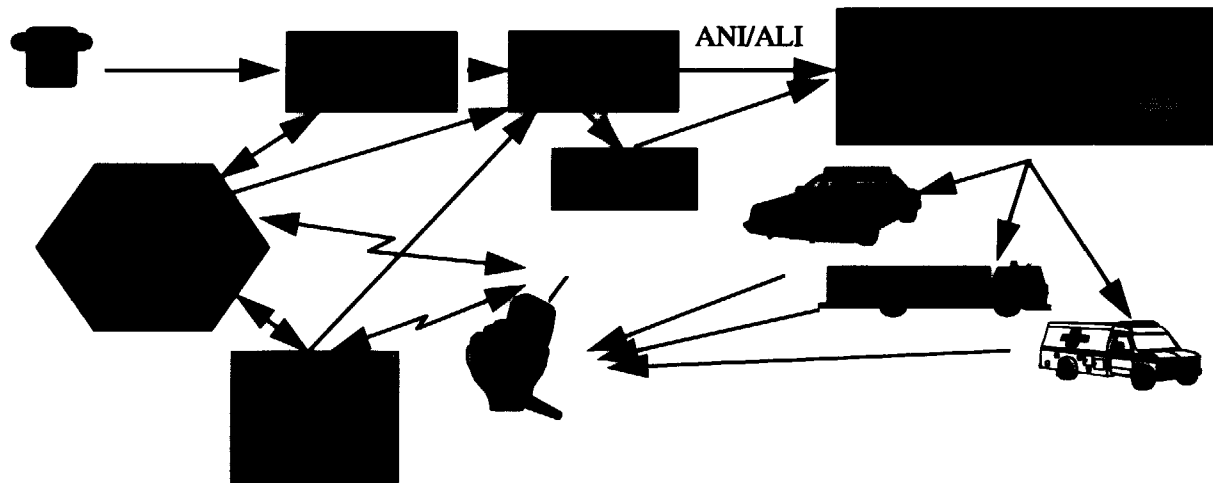
- Field Trials
- Operational Evaluation

Iterative Process

# Cellular Call Scenario and Key System Design Drivers



## Telecommunications Systems



## Cellular Caller E-9-1-1 Scenario

- **Performance**
  - Location: Proximity, Bearing, Location, Tracking
  - Accuracy / Repeatability
  - Response Times
  - Coverage: Range / Sensitivity
  - Processing Loads / Call Density
- **Operational**
  - Operator Interfaces
  - Systems Interfaces
  - Terrain, Multipath, Line-of-Site, Atmospheric
  - Base Station Antenna Gain / Patterns, Losses
  - Warm-up/Re-start, Mobile Life/Recharge times
- **Installation**
  - Fixed / Mobile
  - Environmental: Temperature, Altitude, Vibration, Humidity, Chemical
- **Environments**
  - Physical: Size, Weight, Volume
  - Power Types / Quality, EMI / EMC
- **Phone characteristics**
  - Power Levels
  - Antenna Locations / Orientation
  - Duration / Dropouts
  - RF Characteristics
- **Supportability**
  - Installation / Siting
  - Reliability
  - Maintenance / Equipment
  - Safety
  - Training
  - Manuals
- **Producibility**
  - Schedule
  - Design to Cost

# Key System Trade Summary



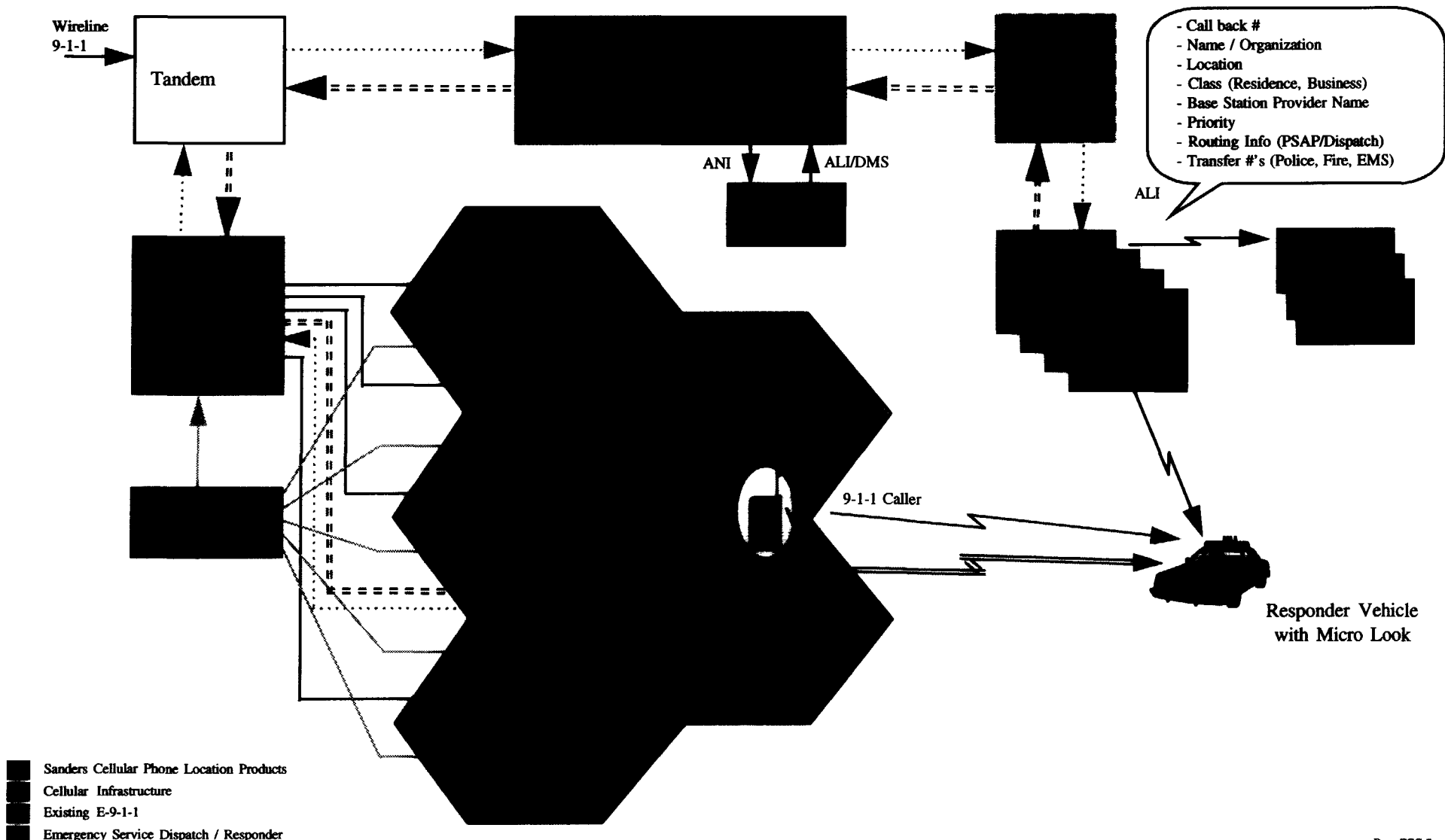
## Telecommunications Systems

Area	Trade/Selection					Key Rationale	
Architecture	<div><div>Fixed Stations Only</div><div>Modular Fixed &amp; Mobile</div><div>Mobile Only</div></div>					<ul style="list-style-type: none"><li>- All area performance</li><li>- Cost Effective</li><li>- Modular Capability</li></ul>	
Fixed Station Technology	<div>AOA</div>	<div>GPS</div>	<div>Narrow Band TDOA</div>	<div>Two Channel TDOA</div>	<div>Other</div>	<ul style="list-style-type: none"><li>- Accuracy</li><li>- Unmodified Phones</li><li>- Cost</li></ul>	
Mobile 2 - Dimension	<div>Line of Bearing (LOB) Only</div>	<div>LOB with Relative Power</div>	<div>LOB with Power &amp; GPS</div>	<div>Other</div>		<ul style="list-style-type: none"><li>- User Interface</li><li>- Performance</li><li>- GPS/Map Optional</li></ul>	
Mobile 3 - Dimension	<div>3-D Line of Bearing (LOB)</div>	<div>Man Portable RMI</div>	<div>Other</div>				<ul style="list-style-type: none"><li>- Performance</li><li>- Low Cost</li></ul>
Fixed Station Sites	<div>New Receiver Stations / Sites</div>	<div>Cell Stations and Antennas</div>	<div>Cell Stations New Antennas</div>			<ul style="list-style-type: none"><li>- Cost Effective</li><li>- Supportability</li><li>- Some new in problem areas</li></ul>	



# Modified E 9-1-1 Network for Location of Cellular Calls

## Telecommunications Systems



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### **User Location Information**

**Phase 2** - ALI Information to PSAP  
**(3 Year)** - Est. of Approx. Locations

Phase 3  
(5 Year)

- ALI Information
- $\leq 125M$  accuracy
- 2D probably okay for Rural
- 3D, Possibly better for urban

**Re-Ring/Call Back**  
(3 Year)

### Common Channel Signaling (3 Year)

- Call Back #
- Mobile Subscriber Name
- Location
- Class of Service
- Base Station providers name, Tel #
- Priority of Call (hospital, school..)
- Routing Information (nearest PSAP)
- Transfer #'s (Fire, police, EMS..)

## Sanders Cellular Phone Location Products

## Cellular Infrastructure

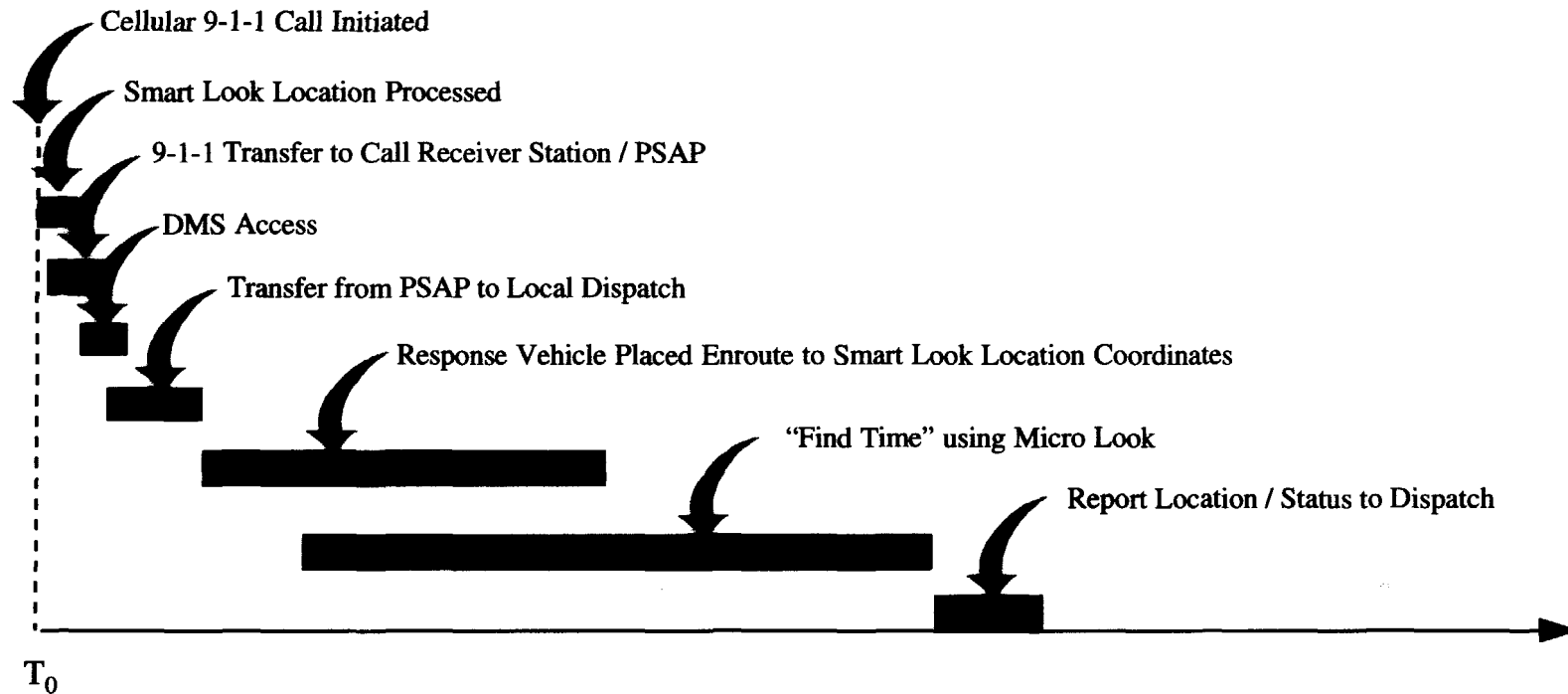
### Existing E-9-1-1 / Wireline Infrastructure

**Emergency Service Dispatch / Responder**

# Cellular E-9-1-1 Call Response Timeline



## Telecommunications Systems



- Sanders Cellular Phone Location Products
- Cellular Infrastructure
- Existing E-9-1-1 / Wireline Infrastructure
- Emergency Service Dispatch / Responder

# Smart Look Wide Area Location System



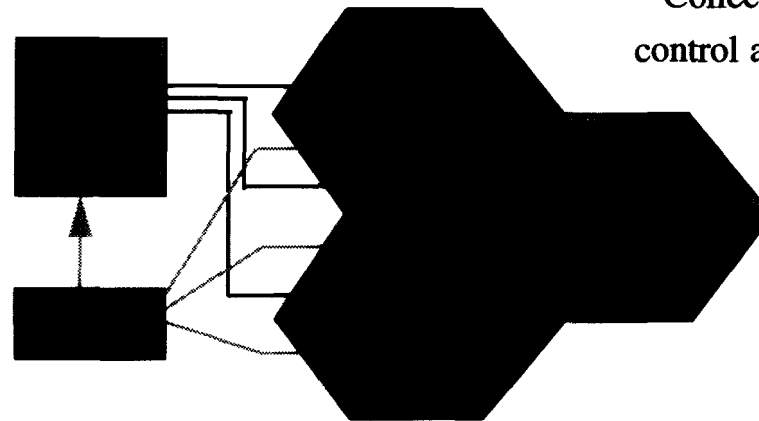
## Telecommunications Systems

### Smart Look Central Unit

- One unit deployed, can handle multiple SL base stations depending on call density
- Processes TDOA to determine location
- Reports to PSAP

### Functional Performance

- Process TDOA
- Graphical user interface
- User Applications
- BIT status and reporting



### Smart Look Base Stations

- Deployed as needed to obtain wide area location
- Collects time difference information from control and voice channels

### Functional Performance

- Monitor for telephone numbers of interest
- Trigger collection
- Pre-processing
- Data transfer

# Smart Look Hardware Status



## Telecommunications Systems



- Pre-Production Units Developed and Tested
- Field Tested in both Nashua and a Major US City
- Over 55,000 hours of local and field run time
- Initial Environmental Testing Performed
- Software Beta Tested including Graphical Users Interface
- Extensive Location Algorithm Development

### Key Physical Characteristics

- Central Unit:
  - Commercial Computer Workstation
  - COTS Routing Equipment
- Base Station Unit:
  - Size: 19" Width  
23.75" Length  
15.75" Height
  - Weight: 61 pounds
  - Power: 115 V AC, 8 Amps
  - Temperature: 0 to +50 °C

# Micro Look Precision Location System



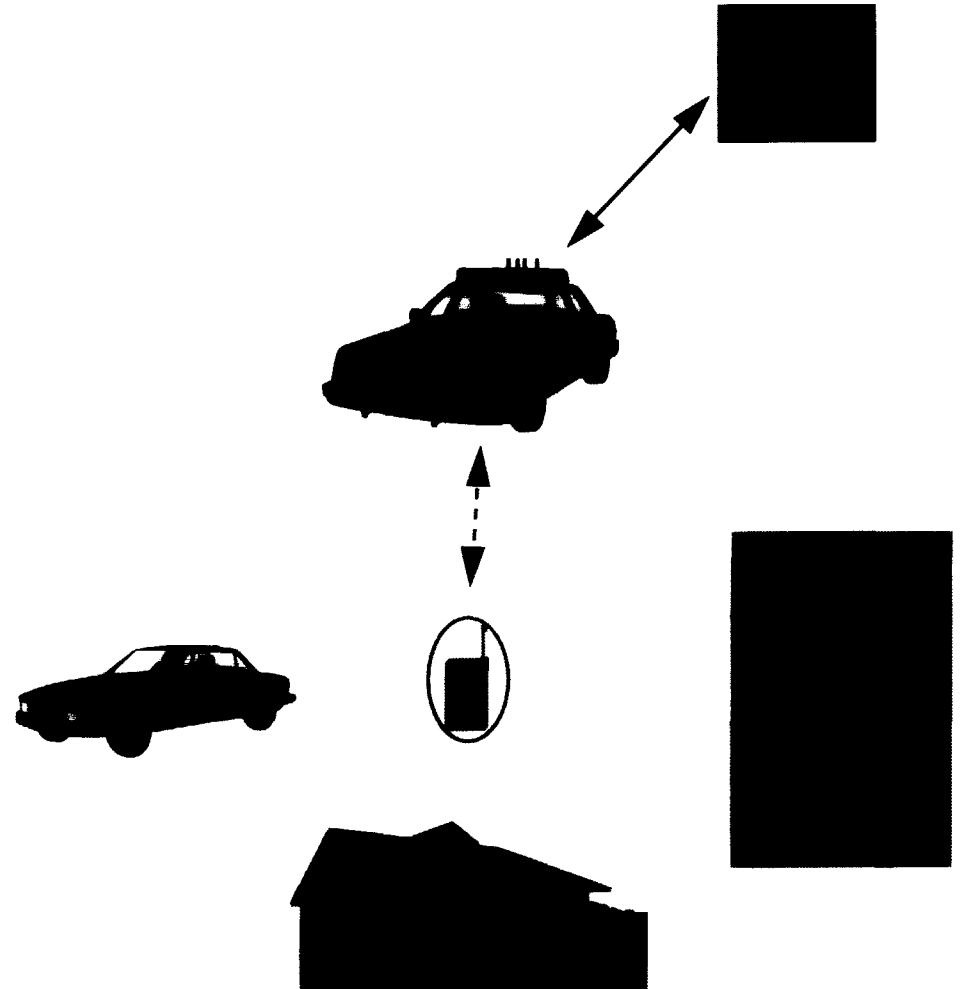
## Telecommunications Systems

### Micro Look System

- Deployed in first response emergency vehicles
- Automated detection of cellular call
- Precise location to the phone in both 2 and 3 dimensions
- Does not require cellular phone modification

### Functional Performance

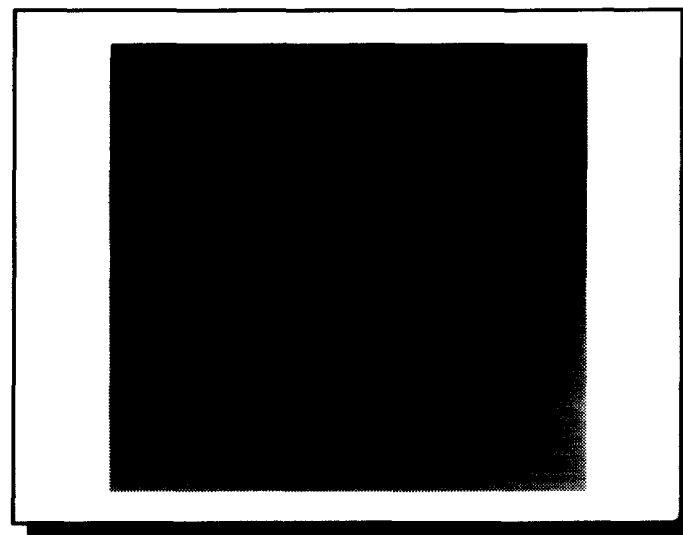
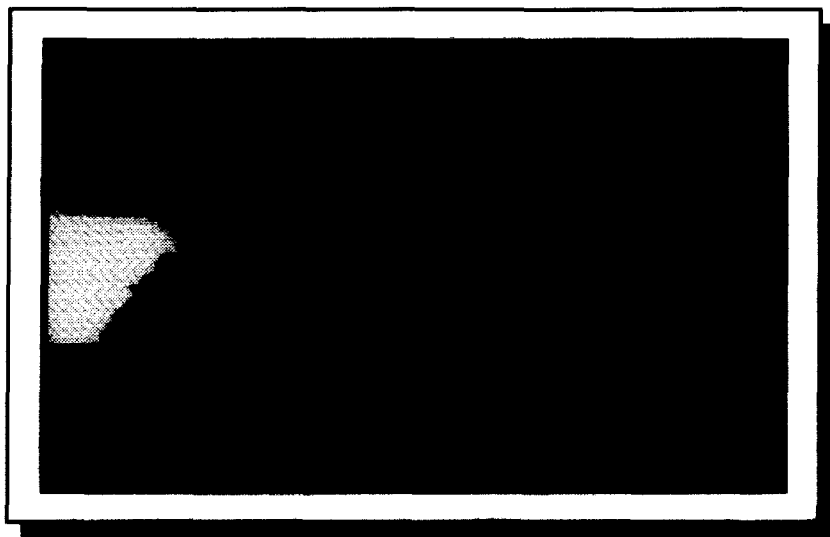
- Locates Transmitting Cell Phone
- Limits False Data caused by Multipath
- Provides Operator Visual and Audio Indications
- Potentially can provide Operator Listening-Access to 9-1-1 Call In Progress to Assist in Rescue Efforts



# Micro Look Hardware Status



## Telecommunications Systems



- Concept Demonstration and Pre-Production Hardware
- FCC Experimental License Received
- Field Tested in Nashua, Manchester and Boston
- Integrated Field Test with Smart Look in Nashua Area
- Preparing for Integrated Field Testing in a Major US City

### Key Physical Characteristics

- Power: Vehicle Power, 12 Watts
- Environmental: -30 to +60° C
- Weight: Less than 12 pounds
- Installation:
  - Removable components
  - Wiring Kit allows Connect & Go operation

# Combined System Performance Exceeds Accuracy Requirements

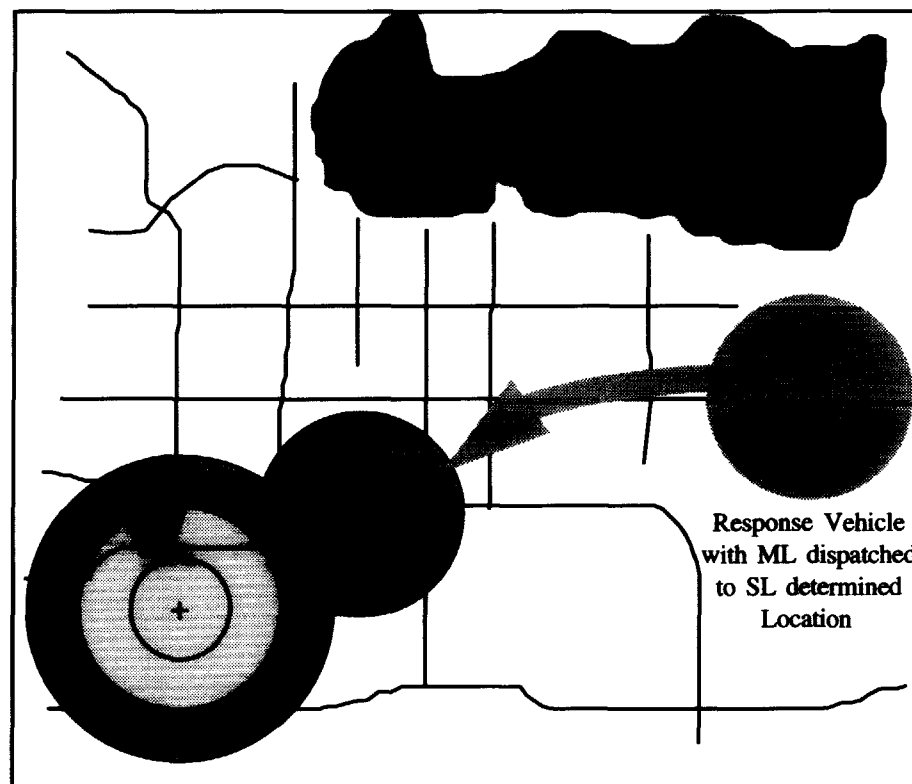


## Telecommunications Systems

Integrated Performance with  
Smart Look Wide Area Location and  
Micro Look Precision Area Location  
allow Location of Cellular Caller to  
Less than 125 Meters  
in both 2 and 3 Dimensions

- Handoff Accuracy Varies:
  - Siting
  - Environment
  - Phone Operating Characteristics
- Handoff Allows:
  - Reduced Base Station Deployments
  - Better Location Accuracy
  - Location Accuracy in 2 and 3 Dimensions

## Dense Urban Response Scenario



+ Smart Look Dispatch Location  
Smart Look Location Accuracies:  
1000 to 3000 feet

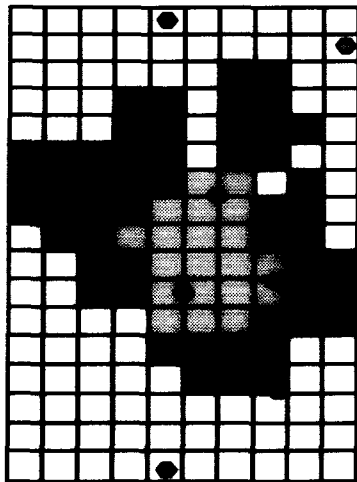
Micro Look Detection Range:  
2000 feet



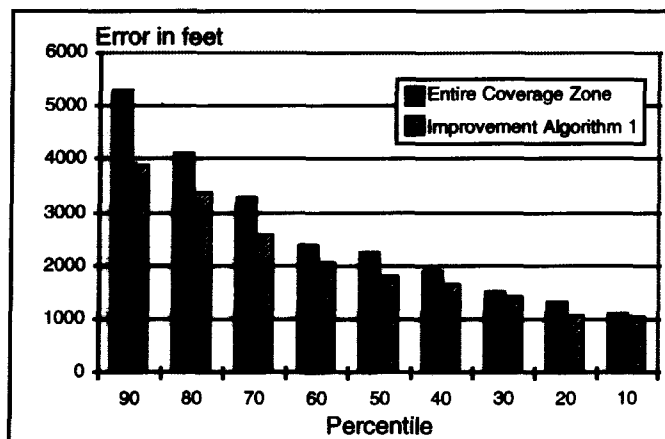
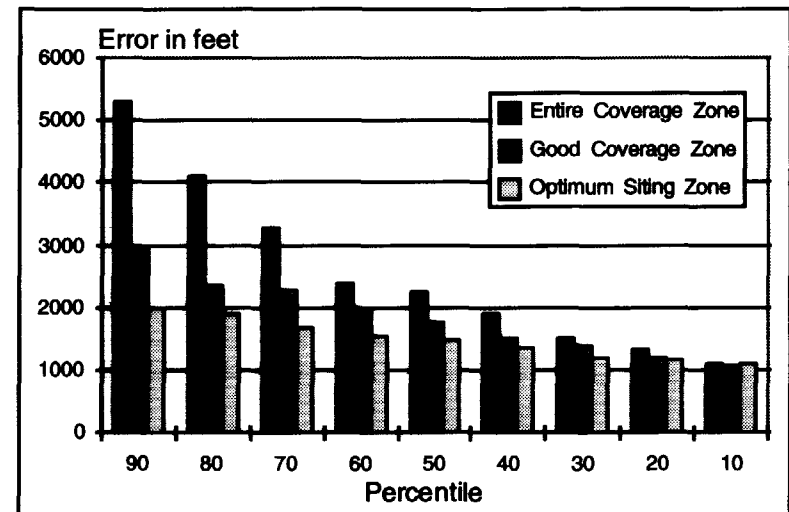
# Smart Look Wide Area Location Dense Urban Environment Field Trials

## Telecommunications Systems

Test Grid and Base Stations



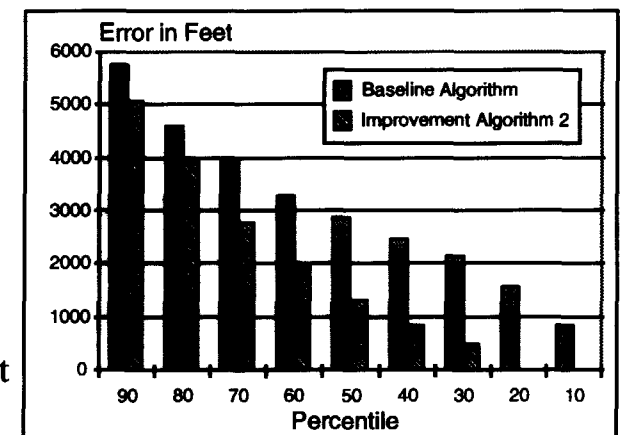
- Major US City
- 8 Sites Operational
- 78 Trial Locations
- 344 Samples



Provides 5 to 20% improvement



Provides 10 to over 50% improvement



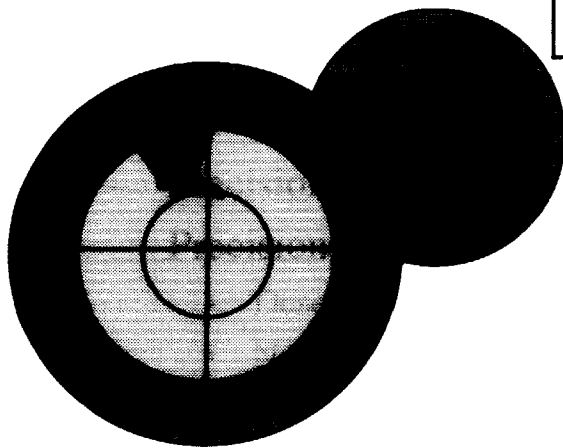
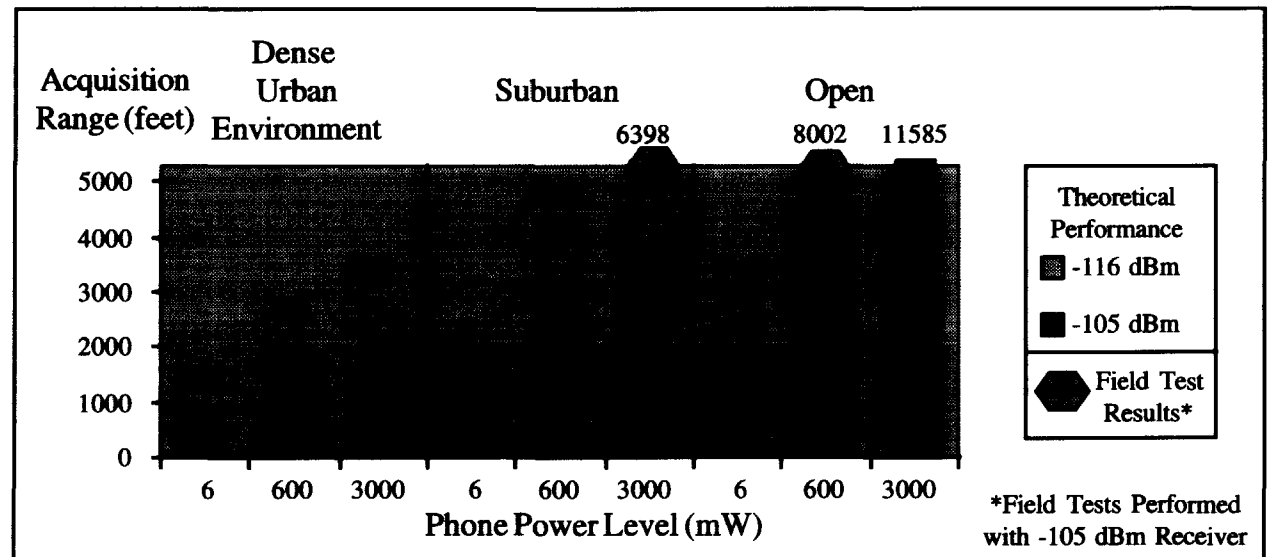
# Smart Look Accuracy Allows Sufficient Hand-off Range for Micro Look Precision Location



## Telecommunications Systems

- Field Testing in
  - Nashua
  - Manchester
  - Boston
- Testing Performed with Prototype Receiver

### Field Test Results



**Phone Always Physically Located**

# Location Accuracy



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## Telecommunications Systems

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- Wide Area Location Accuracy is a Function of:
  - Direct Line of Sight (LOS) to Each Caller Required to Achieve High Accuracy
  - Even Direct LOS will not provide High Accuracy All the Time
    - Weather
    - Atmospherics
  - Location Accuracy and Communication Signal will always be Statistical
- Wide Area Location, supported with Precision Location provides Cost Effective Implementation
  - Wide Area Location can be supported within existing cellular base station infrastructure, minimizes installation costs and siting issues
    - Trade-off issues between urban, suburban, and rural
  - Precision Location finds the Phone Directly
  - Precision Location supports find in All Coverage Areas:
    - Desolate highways
    - National forests
    - Coastal regions

# Summary



## **Telecommunications Systems**

- Work with existing installed base of over 25 million cellular phones
- Provide flexible integration into evolving E-9-1-1 infrastructure
- Provide precise location accuracy
- Provide for tracking the location of moving phones
- Be cost effective and affordable on a system-wide basis
- Be ready for a timely implementation

**Our Solution Supports an Economically Feasible, Location Performance  
of Less Than 125 Meters**